International Journal of Engineering Practical Research
IJEPR Volume 1, Issue 1, August 2012 PP. 6-9

Renovated Engineering Technology Education in Engineering Majors and Future Trends

Jeremy (Zheng) Li
Department of Mechanical and Manufacturing, University of Bridgeport, Bridgeport, CT, USA
Email: zhengli@bridgeport.edu

(Abstract) The computer and internet development improves school faculty's teaching styles in many engineering schools. This paper analyzes the current aspects and future trends of education in mechanical and manufacturing engineering. As the engineering fields continue to grow, the educational research and development are required to prepare engineering students to take their future responsibilities while maintaining identity in their technical backgrounds. The objective of this paper is to provide valuable information for engineering students by studying developed patterns in current and future education, and finding the strategic directions of education and research in the colleges. It is important to share the use of high tech tools and valuable computational modeling tools in the engineering education to guide students to face current and future of engineering complexity and tasks. It is critical for engineering faculties to present and share their industrial and engineering experiences with students, and lead students in the right research and engineering directions.

Keywords: Computational Modelling; Cost-effective Analysis; Engineering Strategy; Lean; FMEA; SOP.

1. INTRODUCTION

The internet and computer technical development provide many possibilities for continuous educational reforms, better learning environments, and more accessible information than we could possibly gain in traditional education [1]. The communication via internet provides more possibilities for better problem solving and reinventing the way that we are learning and teaching in the schools. In this challenging world, teachers and students all prefer "on-demand," virtual learning to traditional education programs. This trend will change the ways information has been transferred and retained [2]. Currently, many textbooks normally need about 2 to 6 years to print and publish before colleges can get them. Because of this, future textbooks will be provided from online and compact disks allowing education information to be more and easily updated with efficient cost-saving [3]. Virtual education will speed learning process through interactive multimedia resources. The internet will allow students to take a greater advantage in developing the way they learn best. Keeping teachers and students to higher education standards needs developing and implementing the innovative and efficient ways of teaching and learning [4]. Also the computer aided modeling of industrial and engineering problem efficiently help teachers and students to get more accurate and quick solutions. Educational accountability will promote educators to determine and build their student's individual learning styles [5].

Many students enrolling into the engineering major will have the difficulty to choose an appropriate engineering discipline [6]. One of the good ways is to explore more updated information from internet to cover the disciplines through multidisciplinary engineering studies and provide students with the real industrial case study and feasible/potential solutions. The research and education via internet will quickly give students broader view of current and latest engineering technologies and its future trend [7]. The explanation of how engineers in different disciplines can contribute to the solution of the engineering issue could become the feasible ways of obtaining a general idea of what is the duty of engineers in each engineering discipline [8]. Related engineering examples from industry are good resources in the engineering classroom, and it can be applied to help students to understand the real issue and to show how the technical concept can be used in real cases and industrial problems can be solved by computer aided modeling and solution.

2. ENGINEERING CASE STUDY VIA INTERNET EXPLORATION AND COMPUTER AIDED MODELING

The engineering case study using Failure Model and Effects Analysis (FMEA) via internet resources has been applied to many different industries for decades which can save product process expenses, increase the manufacturing efficiency, improve the product quality and shorten the production period which will enhance the company's competition in the market. To help students to Understand the potential failure causes and related effects on industrial business and manufacturing processes, several computer modeling and simulation tools have been applied in the classes to guide students in analyzing the major factors that affect the business operation, manufacturing processes, process

efficiency, product quality and production quantity. FMEA strategy is to find risks and try to control or reduce the risks in business operations. Analyzing the risks can plan business operation more realistic and feasible. In FMEA analytic mode, the timely sequenced failure events must be determined and analyzed first before adding the failure results into the FMEA recording sheet. It is difficult to guess the unanticipated failure mechanisms and risks in business operations and FMEA strategy is a powerful business tool to analyze the failure mechanisms to predict future possible failures in business operation. It is very important to well understand the failure cause and effective solution to build up strong FMEA strategic results. All these FMEA knowledge can help college students, our future engineers and researchers, to be ready for future career challenges.

The case study of Lean Manufacturing through internet can help students to understand how to improve the business operation including engineering project handling, inventory planning, quality control, scheduling performance, and customer satisfaction. Also, by applying the Standard Operation Procedures (SOP) and ISO 9001/ISO14000 standard in business operation, the company performance in production work flow, business functions, quality control, and inventory logistics can be significantly improved.

The case study through internet and computer aided simulation introduced in the college class can help students to define the failure modes from business functional requirements and its related effects. A failure-resultant effect can be considered as the result of a failure mode on business function. It is critical to record the effects to gain what causes the failure experiences. The failure effect cases include: disqualified performance, enlarged equipment noise or even severe personal injury. Some important parametric factors can be detailed as follows in the case analysis: (1). Risk (R): Each effect can be assigned a risk number R from 1 (least risk) to 10 (maximum risk) to help company in identifying the failure levels. If risk level is higher than 9, necessary steps must be taken to improve the product design by solving problems to satisfy customers. The risk rating higher than 9 is generally considered for the resultant effects causing product failure. (2). Possibility (P): It is important to study the failure cause to understand how often the failure can occur. This study can be performed by comparing similar product failures that have been previously recorded. The failure is the product design weakness and all the related failure modes should be recorded and verified. The possibility P of the failure mode ranges from 1 to 10. The necessary improvement must be made if the P is high (i.e. > 5 for non safety failure modes, and > 2 when the risk number is higher than 9). (3). Measurement (M): When necessary modifications are planned, it is critical to judge these methodology efficiencies so that the design verification can be performed. The proper measuring techniques have to be selected. The company should first decide the planned systematic controls that can either keep failures from occurring or determine the failures before the defects affecting the end users. Company should consider the testing schedule, analytic methodology, monitoring system and some other techniques that can be applied on similar systems to find failures, and determine how likely the failed defects can be identified or measured through these quality controls. The measuring number M represents the capability of planned measurement and testing to eliminate the defects. (4). Failure Priority Numbers (F): The Failure Priority Numbers F can be determined if all the above three steps have been completed. F is not as important as above three numbers R, P and M but it is more indicated values when plan and verify the above improvement actions. After numbers of R, P and M are determined, the number F can be computed by the equation: $F = R \times P \times M$.

The FMEA procedure must be followed in entire business process by which it can efficiently verify the failure areas of greatest concern. The failure modes with highest F must be considered for quick improvement, not to first investigate the failure modes with the highest risk number R since there might be less risk failures R but with more possibility P and difficult measurement M. Through these internet case discussions, the students will understand that, in business and engineering processes, FMEA strategy can provide an analytical approach while dealing with potential product failure modes and its related causes. When analyzing the potential failures in the design and development including product performance, cost, reliability, safety, and quality, the engineering team can apply computer-aided modeling tools to get more information on how to control the business processes to well prevent these potential failures from happening. With FMEA strategy, the company can use this efficient powerful tool to define which risk might have the greatest concern and what corrective action is required before problem arises. The students in the class will learn and understand that the implement of the above specifications will ensure the required product function to meet the customer needs.

Several case studies introduced in the class can help students to understand the mechanisms and functionality of FMEA strategy. Two examples of case study are as follows:
First case study:

One start-up company is planning the business in an industry that is dominated by several famous top 500 companies. In order to help this small company preparing the business strategy to challenge the competence in this industry, please plan and make the proper strategies on following potential products with your analytic opinion (by putting 1st priority, 2nd priority, and 3rd priority):

(1). Large sized products;
(2). Small sized products (normal delivery);
(3). Small sized products (fast delivery);
(4). Special/emergency product replacement;

This case study can help students to gain the knowledge of how to build up the strategy for start-up and small companies to face the strong market challenge. The different priorities will be assigned depending on what technologies are involved in the products. The FMEA strategy guidelines with focus on lean manufacturing will be discussed and learned from this case study.

Second case study:

A mid-sized and high-tech company with well-organized business structure is planning to implement the strategy to improve product function/quality and strengthen its market competition. Please discuss and explain if the following business strategies are good for this company:

(1). Inventory costs a lot and it should be reduced as much as possible;
(2). Not necessary to plan the consequence during production;
(3). The planned production lines requires to have a straight-through work flow for all products;
(4). Manually operated equipments and devices are economically better than the high-tech and automatically controlled equipments;
(5). Product lot scales should be significantly reduced for economic purpose;

This topic can help students to learn how to plan the business strategy for some mid-sized but well-organized companies, and to use the FMEA and lean manufacturing guidelines to assess the business process control and validation assessment. All the questions will be answered based on how much cash flow the business firm has and what future products the company plan to pursue.

3. EDUCATIONAL ENGINEERING ANALYSIS VIA CLASS PROJECT

The analysis of all class projects are conducted in remote engineering environment, based on the updates of current and latest engineering technologies. The sampled class projects are as follows:

Project 1: Planning a new brand of cell phone with competitive features and technologies.

The weak global economic situation has affected the cell phone market. To attract the customers, the products in many companies have been planned with varieties from the simple form to the complex unit. The overall market can be predictable with successful companies leading the product market and less successful companies trying to get into the same product market share. Please study and analyze what business strategy should be planned to narrow the differential gap between the most successful and less successful companies and how to increase the business competition in global market by setting up proper business strategy.

This class project will guide students to learn what business strategies the small / regular companies have to establish in order to be survival in this competitive world, especially many companies are facing the out-sourcing competition. Additional discussion also involve what other business group should to deal with these categories.

Project 2: Organizing the technical product transition from research to development stage

Preparing to start a new product at the emerging technology companies is very challenging. This first planned product is research-based with a mission to produce the proofed concept data. Please discuss to establish the proper business strategy to quickly make the smooth product transition from research to development stages.

This project is selected to help students to understand what critical rules that the company must follow in the process of new product planning and development. All students will also learn how to manage the business in transferring new R&D design concept to the development stage product that is the critical stage before producing the final production products.

4. CLASS EDUCATIONAL PORTFOLIO AND DISCUSSION

The lectures in this class cover the topics of internet exploration of current business development, industrial technology, computer aided modeling on FMEA, and most recent techniques in establishment of the business strategy and lean manufacturing in current and future industries. It illustrates and explains the fundamental of business strategy and manufacturing strategy with performance measurement. All these topics will help students to understand the theoretical basics of setting up business plan, importance of business strategy, and learn how to apply these strategic techniques to the current and future business / industry.

The feedback from our many graduated students who are currently working in different businesses and industries indicated that the knowledge learnt from our class via internet exploration and computer-aided modeling are very important for them to be succeeded in their career to face current challenging world. These strategic techniques will also determine if the businesses will be successful or not. This shows that, if we educate the important technologies to our students early in the school, they can get ready to face the competitive challenge when they leave the school.

5. CONCLUSION

The current fast developing and strong challenging world requires college students/future engineers to gain more advanced and professional engineering knowledge, in order to be successful in their future career. The teaching reform efforts including internet exploration and computer aided modeling in this paper focus on directly improving faculty teaching capability and student learning curve to face current and future challenging world. This course, currently taught at the mechanical/manufacturing engineering majors, was designed to introduce professional issues associated with current US engineering practice. This course places more emphasis on how to guide engineering students to gain the

necessary industrial and engineering knowledge in remote engineering environment, which are usually missing from the current engineering course curriculum, including basic concept in computer-aided modeling of FMEA, Lean Manufacturing, Six Sigma, ISO 9001 and ISO 14000. In addition to the numerous real industrial case studies and discussions, a number of real projects have been developed in this course to help and allow students to actively apply the skills learnt from the lecture. The students will be benefited from these projects by interacting in a group environment with other multidisciplinary students. Finally, the students will learn about business environment in the developing world and prepare feasible solutions to current business and engineering issues. All these useful industrial knowledge, combined with traditional engineering technology taught in current engineering degree level, can help students in their soon job hunting process and future engineering career. The feedback from our many graduated students confirms the promising curriculum reform in this college engineering course.

REFERENCES

[1]. A. J. Mafana, S. P. Brophy and G. M. Bodner. Instructors' Intended Learning Outcomes for Using Computational Simulations as Learning Tools. J. Engineering Education. 101,18, (2012).

[2]. M. Eliot and J. Turns. Constructing Professional Portfolios: Sense-Making and Professional Identity Development for Engineering Undergraduates. J. Engineering Education. 100, 48, (2011).

[3]. T. S. Haeding, D. D. Carpenter and C. J. Finelli. An Exploratory Investigation of the Ethical Behavior of Engineering Undergraduates. J. Engineering Education. 101, 88, (2012).

[4]. J. Walther, N. Kellam, N. Sochacka and D. Radcliffe. Engineering Competence An Interpretive Investigation of Engineering Students' Professional Formation. J. Engineering Education. 100, 68. (2011).

[5]. P. Kim, T. Miranda and C. Olaciregui. Pocket School: Exploring mobile technology as a Sustainable literacy education option for underserved indigenous children in Latin America. J. Educational Development, 28, 435. (2008).

[6]. G.M. Grossman, P.E.Onkol and M. Sands. urriculum reform in Turkish teacher education: attitudes of teacher educators towards change in an candidate nation. J. Educational Development.27, 139, (2007).

[7]. G. Grossman, P. Onkel and M. Sands, Curriculum reform in Turkish teacher education: attitudes of teacher educators towards change in an EU candidate nation. J. Educational Development. 27, 138. (2007).

[8]. G. S. Stump, J. C. Hilpert, J.Husman, W. Chung and W. Kim. Collaborative Learning in Engineering Students: Gender and Achievement.J. Engineering Education. 100, 25. (2011).